US009326396B2

(12) **United States Patent**
Mizoguchi et al.

(10) **Patent No.: US 9,326,396 B2**
(45) **Date of Patent: Apr. 26, 2016**

(54) **ELECTRONIC EQUIPMENT CASING**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 46 days.

(21) Appl. No.: **13/799,332**

(22) Filed: **Mar. 13, 2013**

(65) **Prior Publication Data**

US 2013/0285516 A1 Oct. 31, 2013

(30) **Foreign Application Priority Data**

Apr. 27, 2012 (JP) 2012-102706

(51) **Int. Cl.**
H05K 5/02 (2006.01)
H05K 5/00 (2006.01)
G06F 1/16 (2006.01)

(52) **U.S. Cl.**
CPC ***H05K 5/02*** (2013.01); ***G06F 1/1637*** (2013.01); ***G06F 1/1658*** (2013.01); ***H05K 5/0017*** (2013.01); ***H05K 5/0247*** (2013.01); *Y10T 29/49826* (2015.01)

(58) **Field of Classification Search**
CPC B29C 66/20; B29C 66/05; B29C 66/13; B29C 66/14; B29C 45/0005; B29C 45/14786; G06F 1/1656; G06F 1/1637; G06F 1/1658; G02F 2001/133314; G02F 2001/133325; H05K 5/02; H05K 5/0017; H05K 5/0247
USPC 361/679.21, 800; 349/58, 60, 187, 794; 362/633, 634; 348/794
See application file for complete search history.

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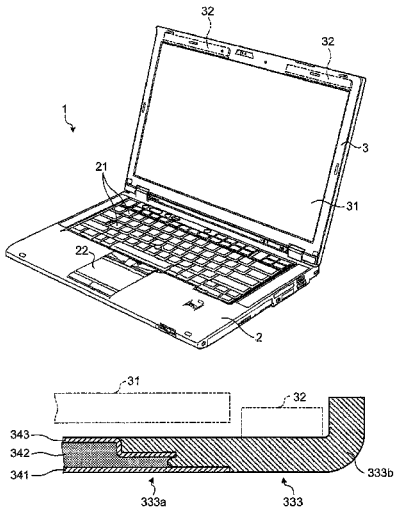
Primary Examiner — Patrick Hawn
(74) *Attorney, Agent, or Firm* — Antony P. Ng; Russell Ng PLLC

(57) **ABSTRACT**

A casing for electronic equipments is disclosed. The casing includes a first region and a second region. The first region is formed by a foamed layer provided between an outer rigid layer and an inner rigid layer. The foamed layer isolates the outer rigid layer from the inner rigid layer. The second region is formed by a single layer of material, and the single layer of material is joined to the outer rigid layer, the formed layer and the inner rigid layer.

7 Claims, 11 Drawing Sheets



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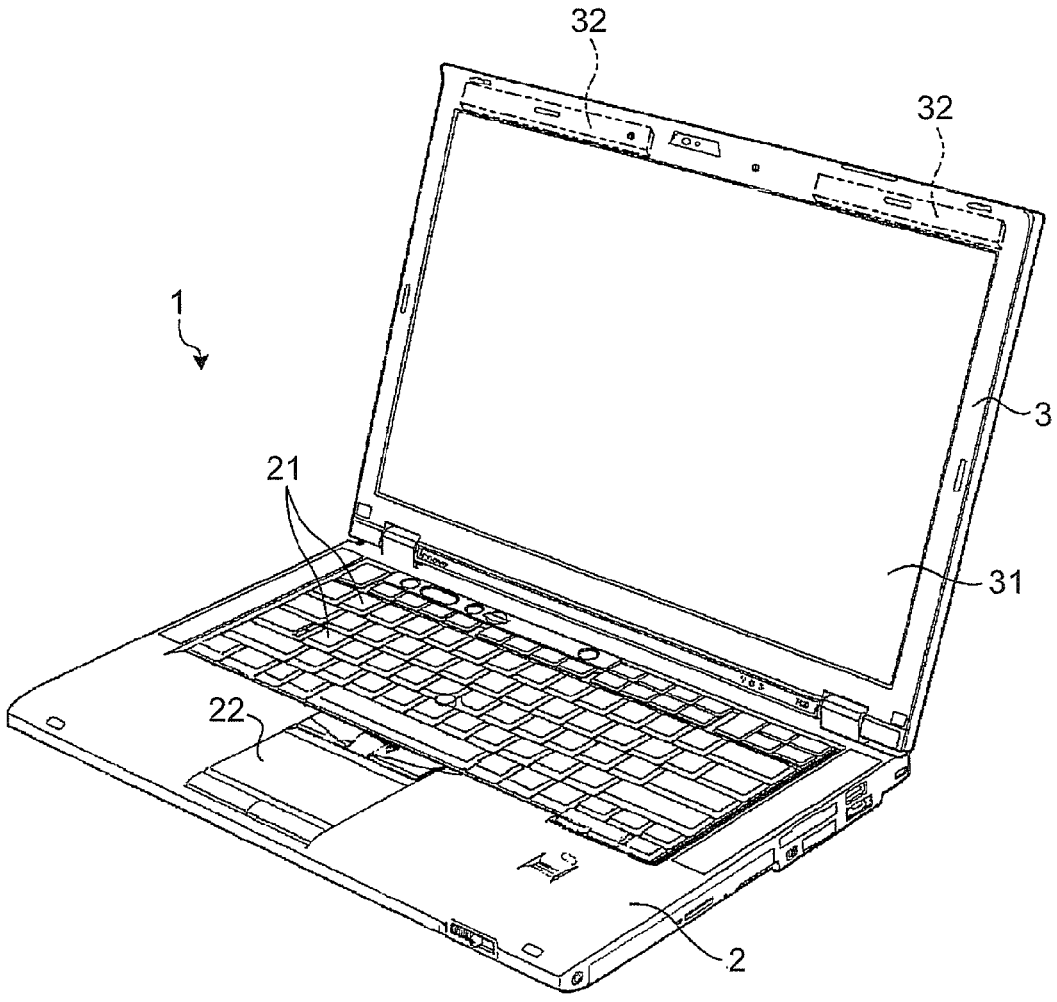

FIG. 1

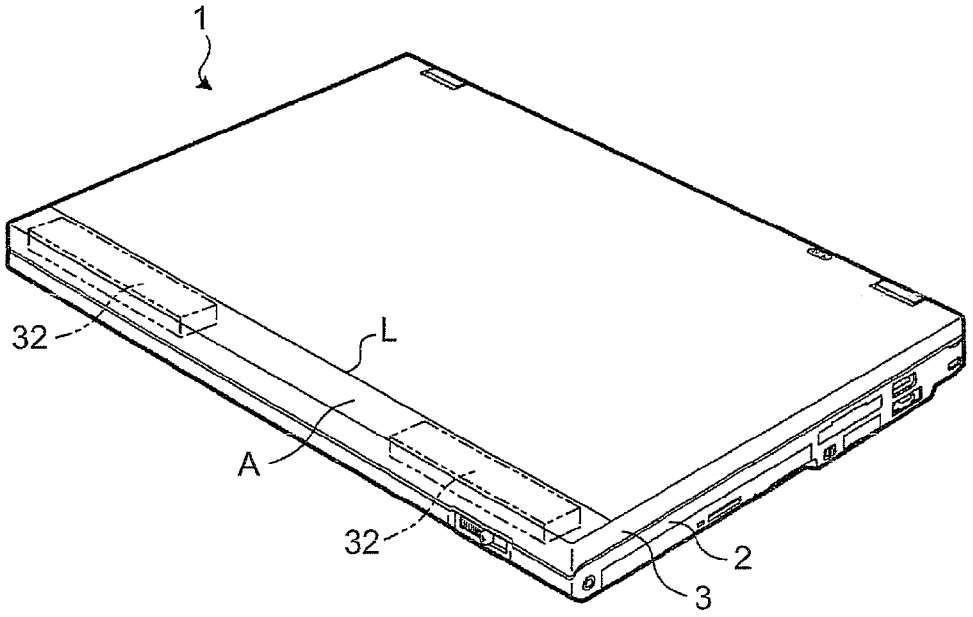

FIG. 2

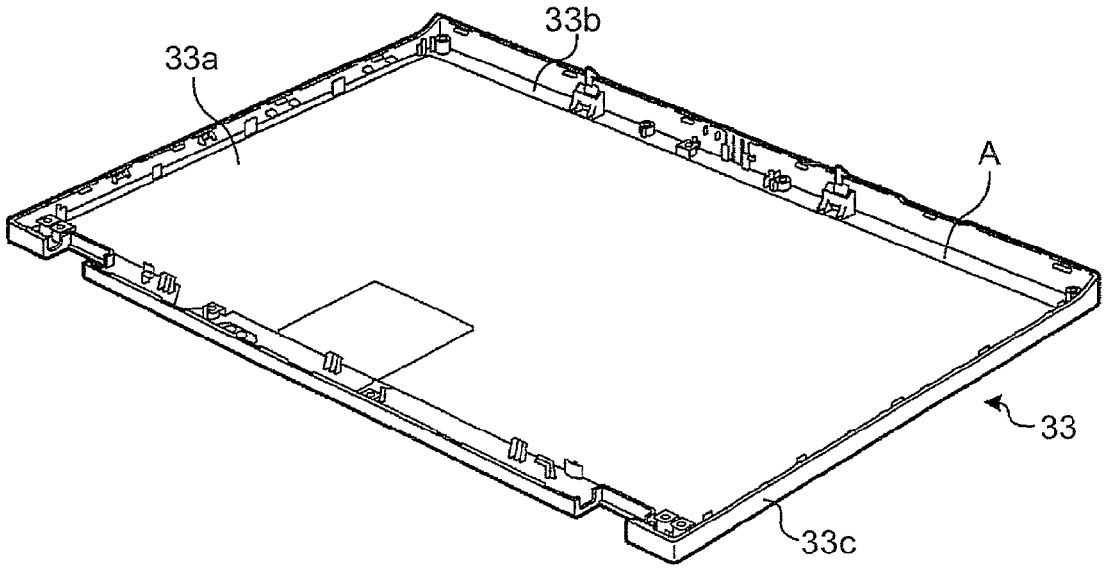

FIG. 3

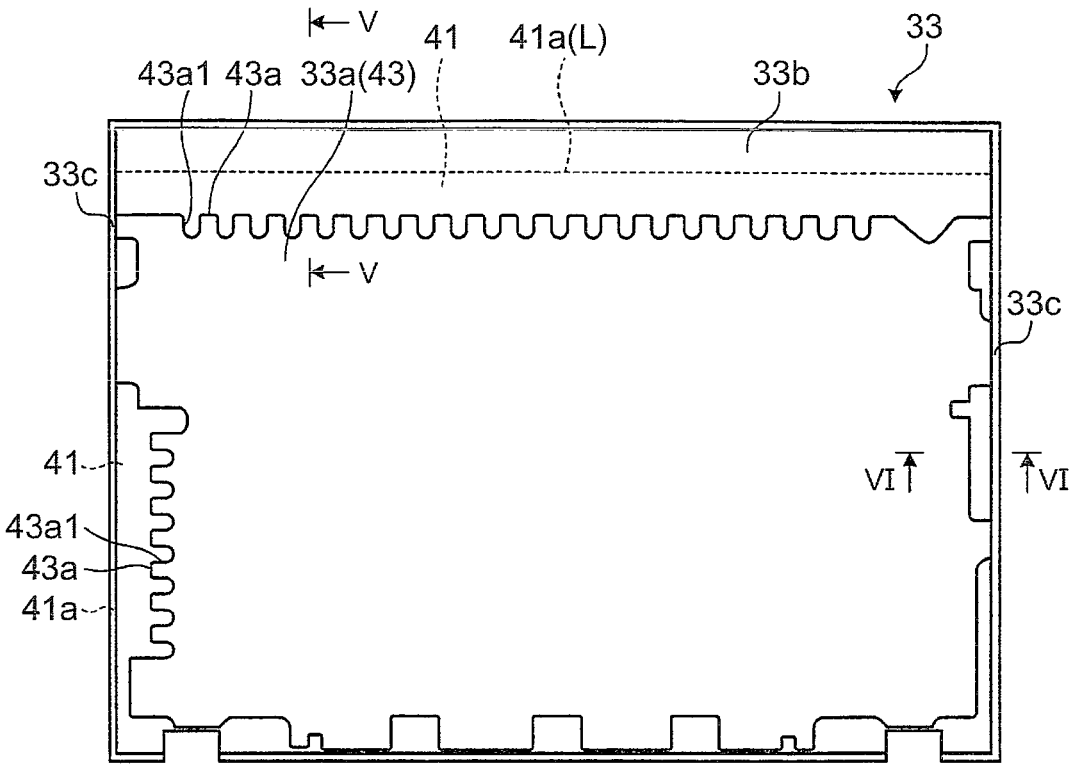

FIG. 4

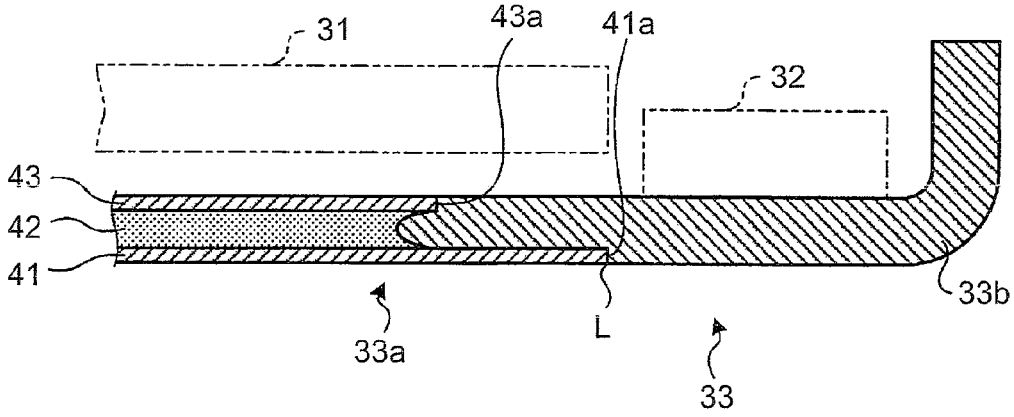

FIG. 5

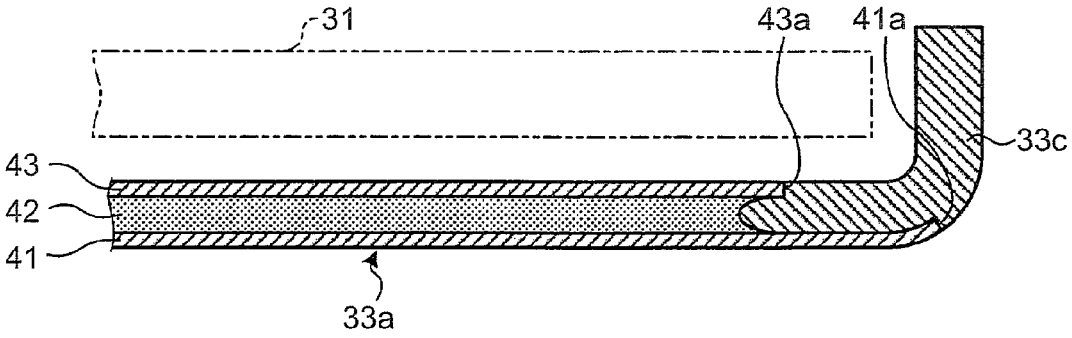

FIG. 6

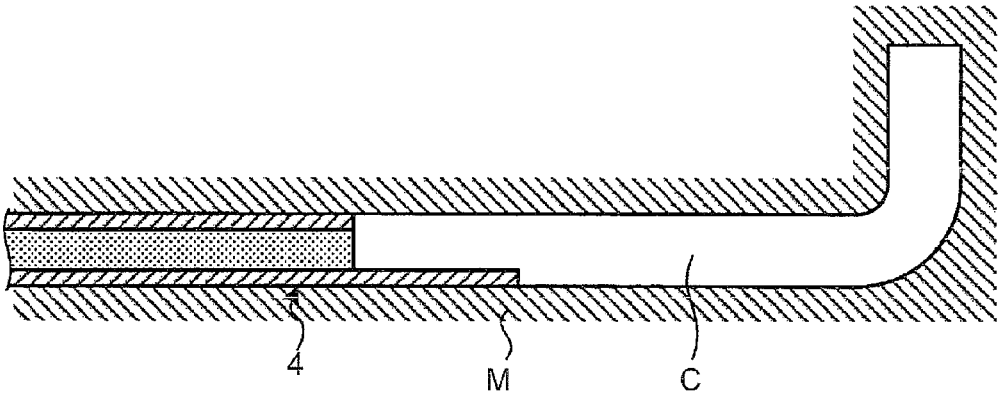

FIG. 7

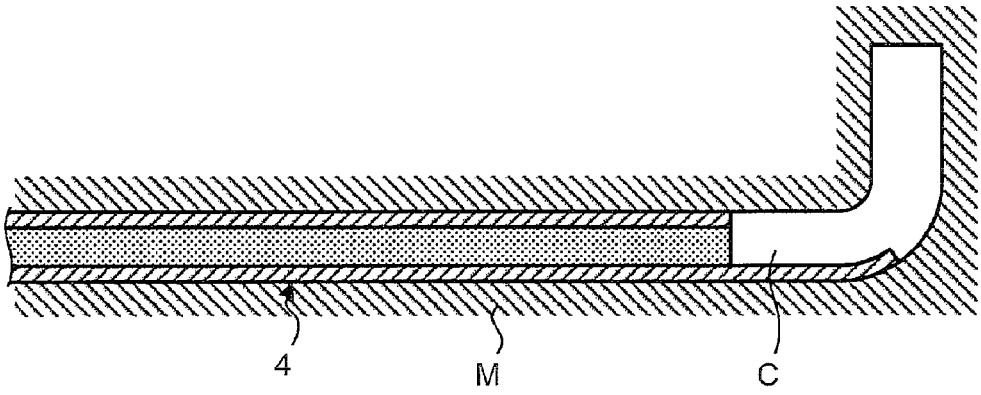

FIG. 8

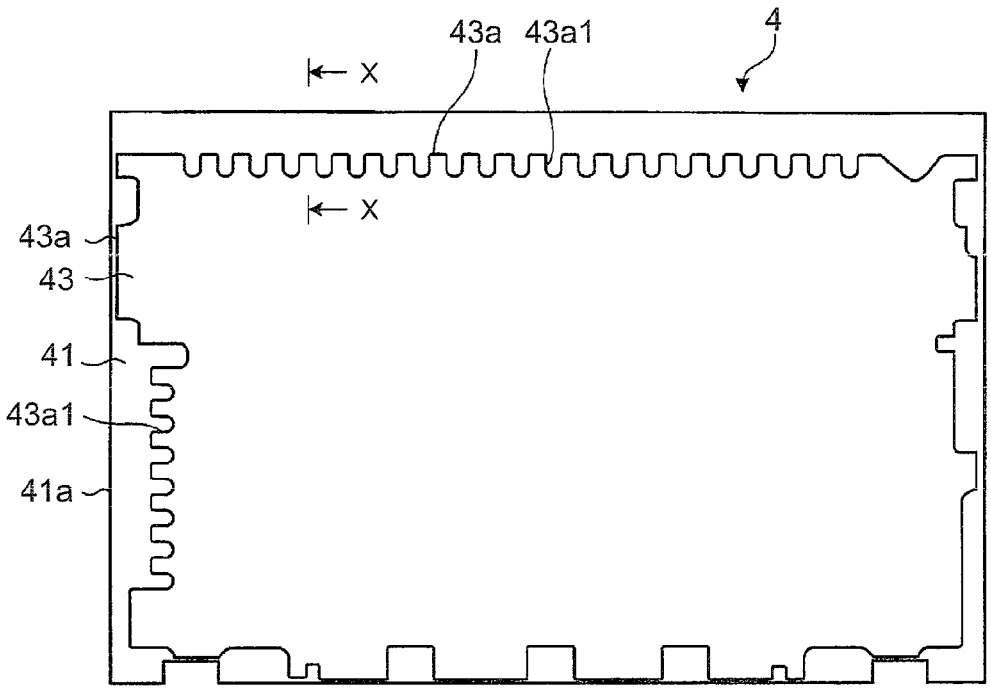

FIG. 9

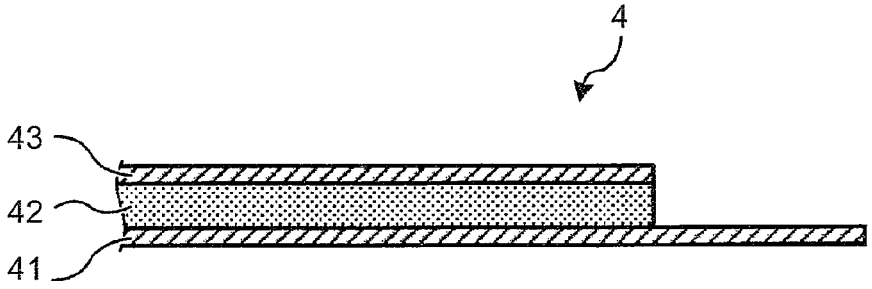

FIG. 10

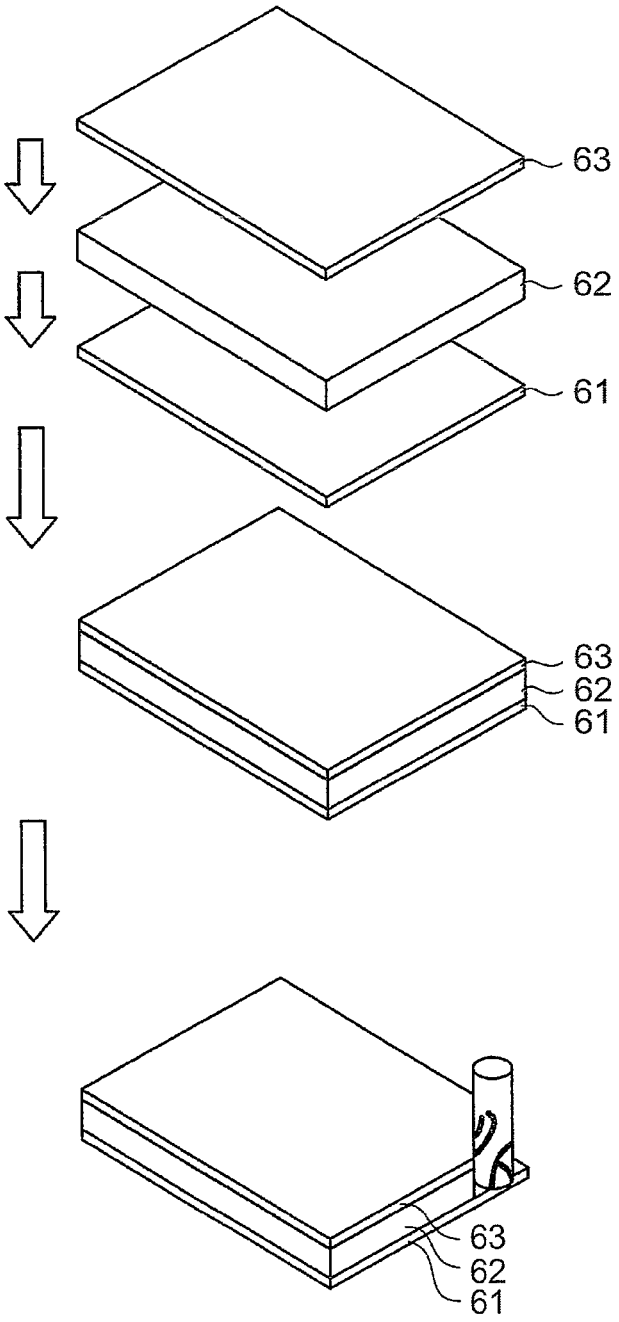

FIG. 11

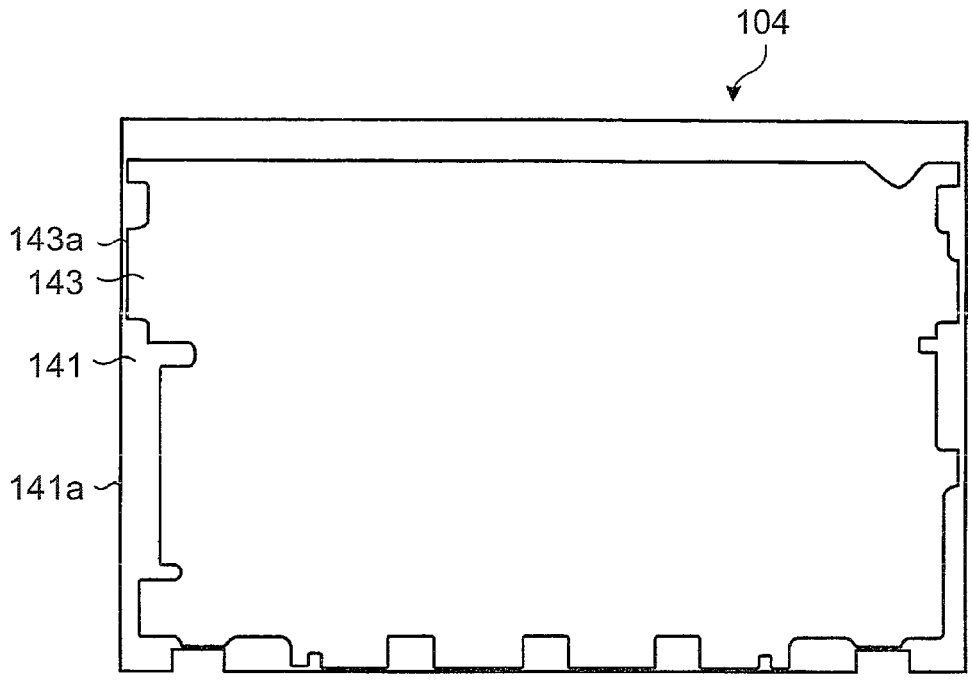

FIG. 12

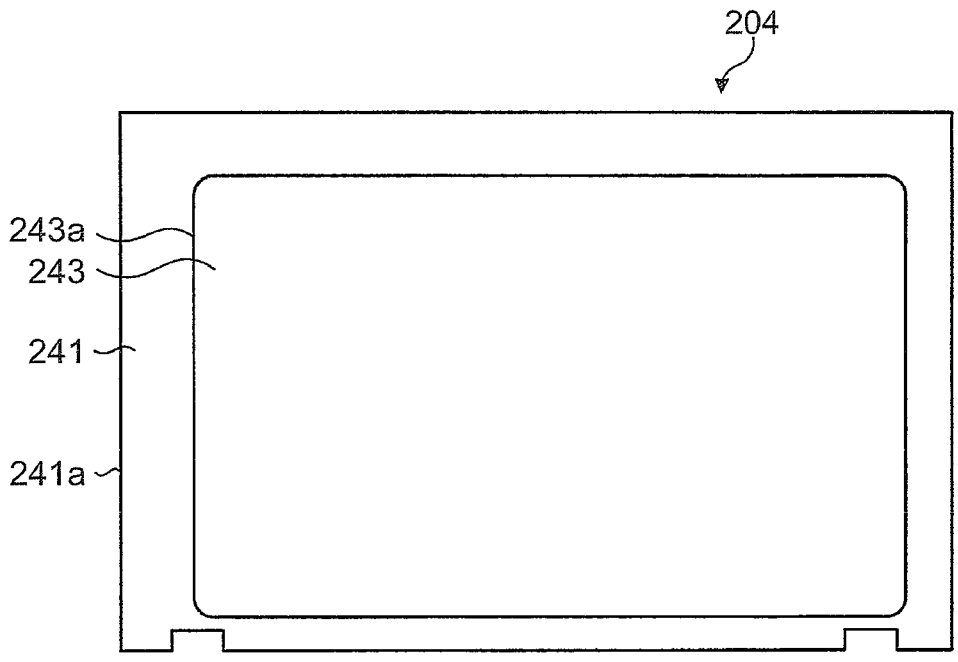

FIG. 13

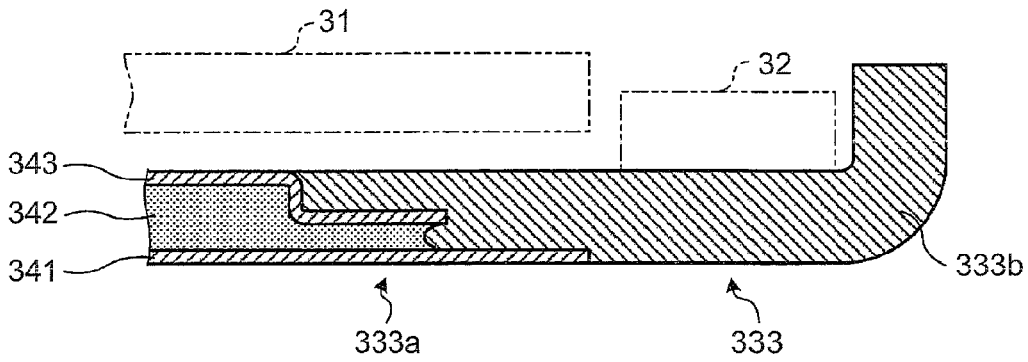

FIG. 14

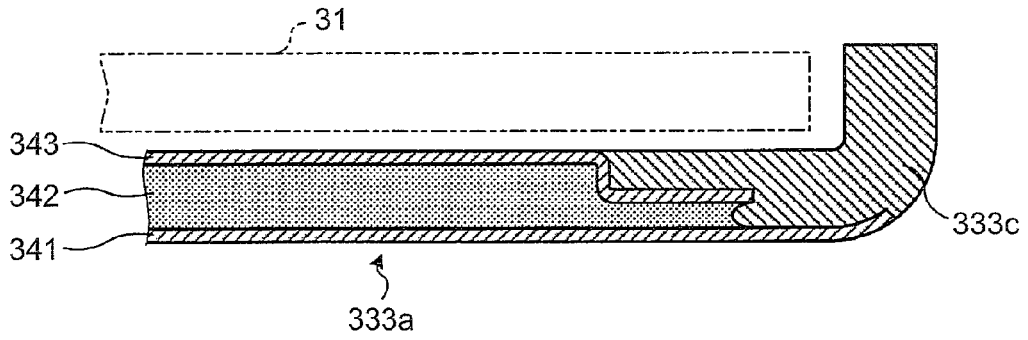

FIG. 15

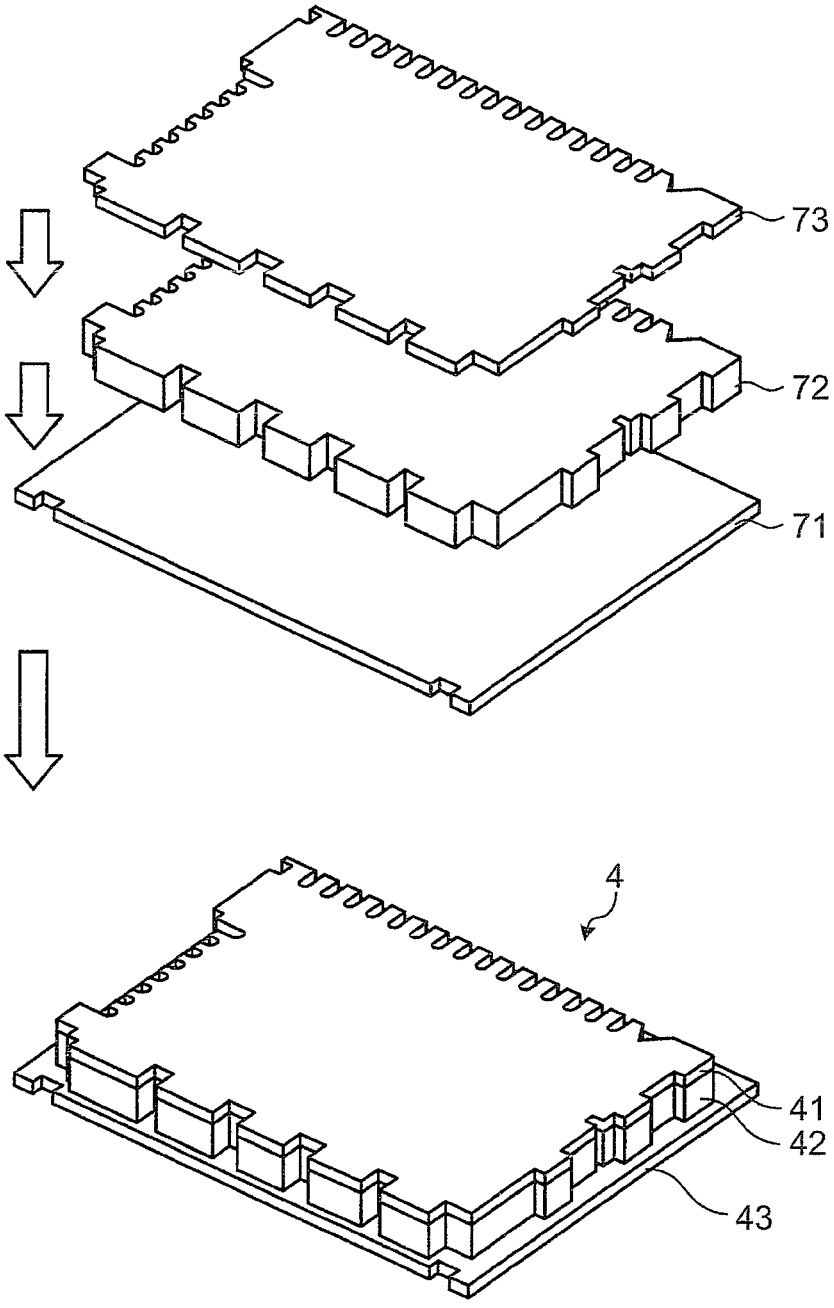

FIG. 16

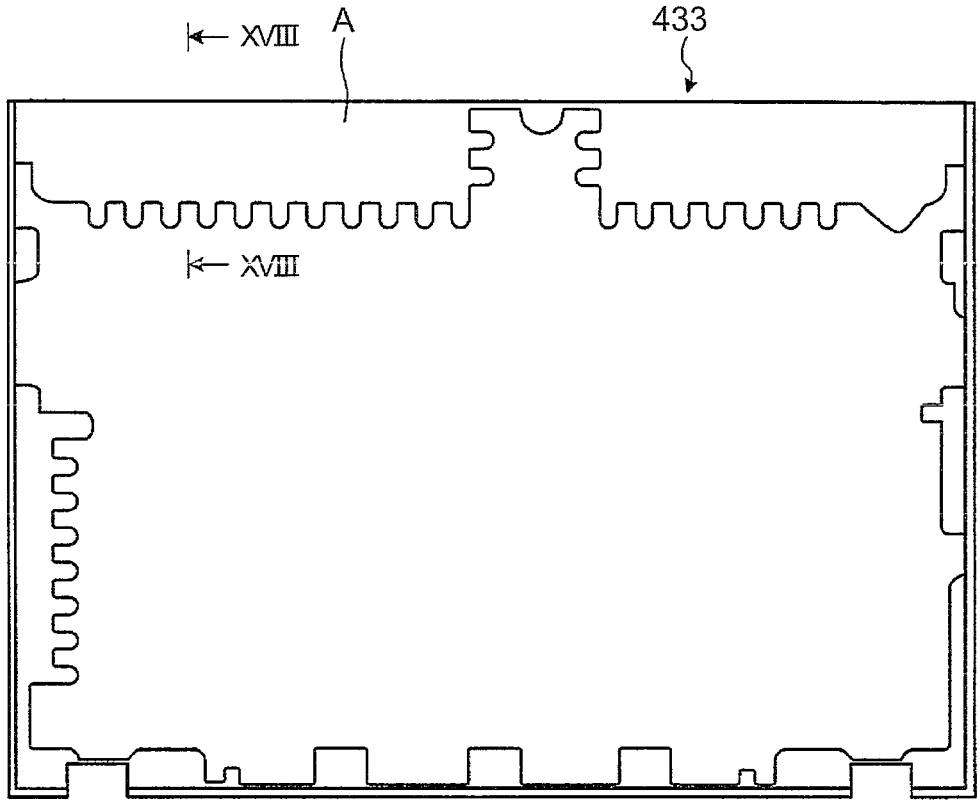

FIG. 17

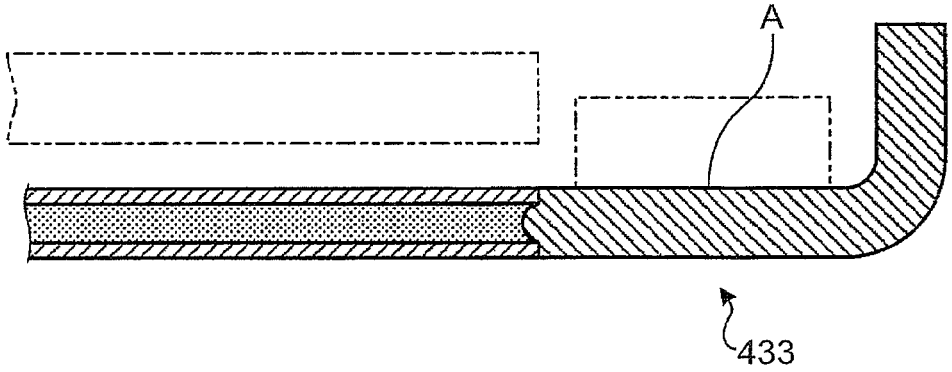

FIG. 18

ELECTRONIC EQUIPMENT CASING

PRIORITY CLAIM

The present application claims benefit of priority under 35 U.S.C. §§120, 365 to the previously filed Japanese Patent Application No. JP2012-102706 with a priority date of Apr. 27, 2012, which is incorporated by reference herein.

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates to casings in general, and more particularly to an electronic equipment casing.

2. Description of Related Art

Nowadays, many electronic equipments, such as laptop personal computers (PCs), are usually equipped with a wireless antenna. The wireless antenna is so arranged that the antenna will become most sensitive when the electronic equipment is used. In a laptop PC, the antenna is placed above or beside a liquid-crystal display (LCD).

In order to place the wireless antenna above or beside the LCD, it is required that an area of a casing where the wireless antenna is placed be made of a non-conductive material, and the area of the casing where the LCD is housed be made of a lightweight material having excellent strength.

Non-conductive materials such as aramid fiber or the like tend to be inferior in strength to the conductive materials. On the other hand, conductive materials such as carbon fiber are lightweight and with excellent strength, but they are unfit to be used in conjunction with wireless antennae.

Consequently, it would be desirable to provide an improved electronic equipment casing for containing an antenna along with a LCD.

SUMMARY OF THE INVENTION

In accordance with a preferred embodiment of the present disclosure, a casing for electronic equipments includes a first region and a second region. The first region is formed by a foamed layer provided between an outer rigid layer and an inner rigid layer. The foamed layer isolates the outer rigid layer from the inner rigid layer. The second region is formed by a single layer of material, and the single layer of material is joined to the outer rigid layer, the formed layer and the inner rigid layer.

All features and advantages of the present disclosure will become apparent in the following detailed written description.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosure itself, as well as a preferred mode of use, further objects, and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

FIG. **1** is a perspective view of a laptop PC in which a preferred embodiment of the present invention can be incorporated, where a cover body is opened from a PC main body;

FIG. **2** is a perspective view of the laptop PC in FIG. **1**, where the cover body is closed over the PC main body;

FIG. **3** is a perspective view of a casing used for the cover body shown in FIGS. **1** and **2**;

FIG. **4** is a top view of the casing shown in FIG. **3**;

FIG. **5** is a cross-sectional view of the casing shown in FIG. **4** at V-V;

FIG. **6** is a cross-sectional view of the casing shown in FIG. **4** at VI-VI;

FIG. **7** is a cross-sectional view for describing a method of manufacturing the casing shown in FIG. **4**, which corresponds to FIG. **5**;

FIG. **8** is a cross-sectional view for describing the method of manufacturing the casing shown in FIG. **4**, which corresponds to FIG. **6**;

FIG. **9** is a top view of a casing material that forms a plate-like part shown in FIG. **4**;

FIG. **10** is a cross-sectional view of the casing material shown in FIG. **10** at X-X;

FIG. **11** describes a method of manufacturing the casing material shown in FIG. **9**;

FIG. **12** is a top view showing a casing material different in form from the casing material shown in FIG. **9**;

FIG. **13** is a top view showing a casing material different in form from the casing materials shown in FIG. **9** and FIG. **12**;

FIG. **14** is a cross-sectional view showing a casing different in form from the casing shown in FIG. **3** to FIG. **6**, which corresponds to FIG. **5**;

FIG. **15** is a cross-sectional view of the casing shown in FIG. **14**, which corresponds to FIG. **6**;

FIG. **16** describes a method of manufacturing a casing material different in form from the method of manufacturing the casing material shown in FIG. **11**;

FIG. **17** is a top view of a conventional casing; and

FIG. **18** is a cross-sectional view of the casing shown in FIG. **17** at XVIII-XVIII.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

FIG. **17** is a top view of a conventional casing, and FIG. **18** is a cross-sectional view of the casing shown in FIG. **17** at XVIII-XVIII. As shown, an electronic equipment casing **433** includes an area A to be made non-conductive, and so it is made of a non-conductive material, an area to be made highly strong, and so it is made of a conductive material. The area A to be made non-conductive and the area to be made highly strong are joined together, as shown in FIG. **18**.

FIGS. **1** and **2** are perspective views showing a laptop personal computer (PC) as an embodiment of the present invention, where FIG. **1** shows such a state that a cover body is opened from a PC main body, and FIG. **2** shows such a state that the cover body is closed over the PC main body. As shown in FIGS. **1** and **2**, a laptop PC **1** as the embodiment of the present invention includes a PC main body **2** and a cover body **3** supported to be openable and closable with respect to the PC main body **2**. On the top face of the PC main body **2**, input units such as operation keys **21** and a touch-pad **22** are provided to enter various pieces of information. These input units are covered with the cover body **3** when the cover body **3** is closed over the PC main body **2** (see FIG. **2**). Further, a liquid crystal display (LCD) **31** for displaying various pieces of information is provided on the front face of the cover body **3**. The LCD **31** is covered with the PC main body **2** when the cover body **3** is closed over the PC main body **2** (see FIG. **2**).

As shown in FIGS. **1** and **2**, the laptop PC **1** as the embodiment of the present invention comes already equipped with a wireless antenna **32** in a position above the LCD **31**. Therefore, an area A where non-conductivity is given preference over strength is provided in a casing **33** used for the cover body **3** to install the wireless antenna **32** therein (see FIG. **2**).

FIG. **3** is a perspective view showing a casing used for the cover body shown in FIGS. **1** and **2**. FIG. **4** is a top view of the casing shown in FIG. **3**. FIG. **5** is a cross-sectional view of the

casing shown in FIG. **4** at V-V, and FIG. **6** is a cross-sectional view of the casing shown in FIG. **4** at VI-VI.

As shown in FIG. **3** to FIG. **5**, the casing **33** used for the cover body **3** has a lightweight plate-like part **33***a* having excellent strength, an antenna part **33***b* superior in non-conductivity to the plate-like part **33***a*, and a marginal part **33***c* superior in moldability to the plate-like part **33***a*.

As shown in FIGS. **5** and **6**, the plate-like part **33***a* is made of three-layered fiber-reinforced plastic, while the antenna part **33***b* and the marginal part **33***c* are made of single-layered fiber-reinforced plastic. The plate-like part **33***a* has an outer rigid layer **41**, a foamed layer **42**, and an inner rigid layer **43** in the thickness direction, and the antenna part **33***b* or the marginal part **33***c* is jointed to the outline of the plate-like part **33***a*.

The outer rigid layer **41** is a rigid layer, and a boundary line L between the outer rigid layer **41** and the antenna part **33***b* appears on the outer surface of the casing **33** (see FIG. **2**). The outer rigid layer **41** is made of woven or two-layered carbon fiber (CFRP). When the outer rigid layer **41** is made of woven carbon fiber, the woven texture appears on the outer surface of the casing **33**. On the other hand, when the outer rigid layer **41** is made of two-layered carbon fiber, fiber yarns are aligned in one direction so that upper-layer carbon fiber will intersect with lower-layer carbon fiber, and hence such a fiber pattern that fiber yarns are aligned in one direction appears on the outer surface of the casing **33**.

The foamed layer **42** is provided between the outer rigid layer **41** and the inner rigid layer **43** to isolate the outer rigid layer **41** and the inner rigid layer **43**. As a result, the plate-like part **33***a* has a large section modulus with a lightweight and excellent-strength structure.

As shown in FIG. **4** to FIG. **6**, the inner rigid layer **43** is a rigid layer appearing on the inner surface of the casing **33**, and the outline **43***a* of the inner rigid layer **43** is formed more inwardly than the outline **41***a* of the outer rigid layer **41**. As a result, the inner rigid layer **43** is hidden in the outer rigid layer **41** without appearing on the outer surface of the casing **33**. Therefore, as shown in FIG. **4**, even if concave portions **43***a***1** are provided to increase the junction area of the inner rigid layer **43** with the antenna part **33***b* or the marginal part **33***c*, the curved patterns will not appear on the outer surface of the casing **33**.

Further, as a result of forming the outline **43***a* of the inner rigid layer **43** more inwardly than the outline **41***a* of the outer rigid layer **41**, a step is made between the outline **43***a* of the inner rigid layer **43** and the outline **41***a* of the outer rigid layer **41**. Therefore, the outer peripheral edge of the outer rigid layer **41** as the step becomes a join surface to the antenna part **33***b* or the marginal part **33***c*.

The single-layered fiber-reinforced plastic that is formed into the antenna part **33***b* and the marginal part **33***c* is excellent in non-conductivity and moldability, which is made of glass fiber (GFRP).

The joint part between the inner rigid layer **43** and antenna part **33***b*, and the joint part between the inner rigid layer **43** and the marginal part **33***c* do not appear on the outer surface of the above-mentioned casing **33**, resulting in an excellent appearance of the casing **33**.

FIGS. **7** and **8** are cross-sectional views for describing a method of manufacturing the casing shown in FIG. **4**, where FIG. **7** corresponds to FIG. **5** and FIG. **8** corresponds to FIG. **6**. The casing **33** is manufactured using a prepreg of three-layered fiber-reinforced plastic and molten fiber-reinforced plastic.

Specifically, as shown in FIG. **7** and FIG. **8**, a casing material **4** (the prepreg of three-layered fiber-reinforced plastic) that is formed into the plate-like part **33***a* is set in a mold M, and the molten fiber-reinforced plastic is filled up in a cavity C provided in the mold M. Thus, the fiber-reinforced plastic is injection-molded so that the antenna part **33***b* or the marginal part **33***c* will be formed in the outline of the plate-like part **33***a* as shown in FIGS. **5** and **6**. At this time, the fiber-reinforced plastic that is formed into the antenna part **33***b* or the marginal part **33***c* penetrates into the foamed layer **42** that forms part of the plate-like part **33***a*, and the antenna part **33***b* or the marginal part **33***c* obtains an anchor effect after that.

In the above-mentioned method of manufacturing the casing, since the casing material that is formed into the plate-like part **33***a* is set in the mold M and the molten fiber-reinforced plastic is filled up in the cavity C provided in the mold M to form the antenna part **33***b* or the marginal part **33***c* as a non-conductive area at the outer side of the plate-like part **33***a*, there is no need to joint the antenna part **33***b* or the marginal part **33***c* to the plate-like part **33***a* after the antenna part **33***b* or the marginal part **33***c* is formed.

FIG. **9** is a top view showing the casing material that is formed into the plate-like part shown in FIG. **4**. FIG. **10** is a cross-sectional view of the casing material shown in FIG. **9** at X-X. As shown in FIGS. **9** and **10**, the casing material **4** that is formed into the plate-like part **33***a* is made up of the outer rigid layer **41**, the foamed layer **42**, and the inner rigid layer **43**, and the antenna part **33***b* or the marginal part **33***c* is jointed to the outline (see FIG. **5** and FIG. **6**).

The outer rigid layer **41** is made of woven or two-layered carbon fiber (CFRP). When the outer rigid layer **41** is made of woven carbon fiber, the woven texture appears outwardly. On the other hand, when the outer rigid layer **41** is made of two-layered carbon fiber, fiber yarns are aligned in one direction so that the upper layer of carbon fiber will intersect with the lower layer of carbon fiber, and hence such a fiber pattern that fiber yarns are aligned in one direction appears outwardly.

As shown in FIG. **9** and FIG. **10**, the foamed layer **42** is provided between the outer rigid layer **41** and the inner rigid layer **43** to isolate the outer rigid layer **41** and the inner rigid layer **43**. As a result, the casing material **4** has a large section modulus with a lightweight and excellent-strength structure.

Like the outer rigid layer **41**, the inner rigid layer **43** is made of woven or two-layered carbon fiber (CFRP). Further, as shown in FIG. **10**, the outline **43***a* of the inner rigid layer **43** is formed more inwardly than the outline **41***a* of the outer rigid layer **41**, and as shown in FIG. **9**, concave portions **43***a***1** are provided at predetermined pitches to obtain a join strength to the antenna part **33***b* or the marginal part **33***c*.

Since the above-mentioned casing material **4** is so configured that the outline **43***a* of the inner rigid layer **43** will be formed more inwardly than the outline **41***a* of the outer rigid layer **41**, the outline **43***a* of the inner rigid layer **43** does not appear on the outer surface of the casing **33**, resulting in an excellent appearance of the casing **33**. For example, as shown in FIG. **9**, even if the concave portions **43***a***1** are provided in the outline **43***a* of the inner rigid layer **43** at the predetermined pitches, the pattern of the depressed portions **43***a***1** does not appear on the outer surface of the casing **33**.

FIG. **11** illustrates a method of manufacturing the casing material shown in FIG. **9**. As shown in FIG. **11**, a rigid sheet **61** formed into the outer rigid layer **41**, a foamed sheet **62** formed into the foamed layer **42**, and a rigid sheet **63** formed into the inner rigid layer **43** are first laminated in this order to produce three-layered fiber-reinforced plastic. Next, the rigid sheet **63** formed into the inner rigid layer **43** and the foamed sheet **62** formed into the foamed layer **42** are so trimmed that

the outline of the inner rigid layer **43** of the produced three-layered fiber-reinforced plastic will be more inward than the outline of the outer rigid layer **41**. Specifically, as shown in FIG. **9**, the rigid sheet **63** and the foamed sheet **62** are trimmed to form the concave portions **43***a***1** in order to obtain a join strength to the antenna part **33***b* or the marginal part **33***c*. Thus, the casing material **4** shown in FIG. **9** and FIG. **10** is obtained. Note that, since the rigid sheet **63** and the foamed sheet **62** are trimmed not to damage the rigid sheet **61** formed into the outer rigid layer **41** in order to obtain the performance of the outer rigid layer **41**, the foamed layer **42** may remain. However, since the remaining foamed layer **42** melts by the molten fiber-reinforced plastic, this is not a drawback.

In the above-mentioned method of manufacturing the casing material, since the rigid sheet **63** formed into the inner rigid layer **43** and the foamed sheet **62** formed into the foamed layer **42** are trimmed after the three-layered fiber-reinforced plastic is produced, there is no need to position and laminate the rigid sheet **61** formed into the outer rigid layer, the foamed sheet **62** formed into the foamed layer **42**, and the rigid sheet **63** formed into the inner rigid layer **43**.

FIG. **12** is a top view of a casing material different in form from the casing material shown in FIG. **9**. A casing material **104** shown in FIG. **12** is that an outline **143***a* of an inner rigid layer **143** is approximated to be more linear than the outline **43***a* of the inner rigid layer **43** shown in FIG. **9**. This is because a step is made between the inner rigid layer **143** and an outline **141***a* of an outer rigid layer **141**, and the outer peripheral edge of the outer rigid layer **141** as the step becomes a join surface to the antenna part **33***b* or the marginal part **33***c*, so that the join strength between the plate-like part **33***a* and the antenna part **33***b*, and between the plate-like part **33***a* and the marginal part **33***c* is secured to eliminate the need to provide the depressed portions **43***a***1** as shown in FIG. **9**.

FIG. **13** is a top view of a casing material different in form from the casing materials shown in FIGS. **9** and **12**. A casing material **204** shown in FIG. **13** is that an outline **243***a* of an inner rigid layer **243** is approximated to be more rectangular than the outline **143***a* of the inner rigid layer **143** shown in FIG. **12**. This is not only because the join strength between the plate-like part **33***a* and the antenna part **33***b*, and between the plate-like part **33***a* and the marginal part **33***c* is secured to eliminate the need to provide the depressed portions **43***a***1** as shown in FIG. **9** along the outline **243***a* of the inner rigid layer **243**, but also because the approximation of the outline **243***a* of the inner rigid layer **243** to a rectangle makes manufacturing easy.

FIGS. **14** and **15** are cross-sectional views showing a casing different in form from the casing shown in FIG. **3** to FIG. **6**, where FIG. **14** corresponds to FIG. **5** and FIG. **15** corresponds to FIG. **6**. The foamed layer **42** of the plate-like part **33***a* of the casing **33** shown in FIG. **3** to FIG. **6** is created at a twofold foam expansion ratio (with a thickness twice the thickness of the outer rigid layer **41** and the inner rigid layer **43**). In contrast, a foamed layer **342** of a plate-like part **333***a* of a casing **333** shown in FIGS. **14** and **15** is created at a fourfold foam expansion ratio in a central section (with a thickness four times the thickness of the outer rigid layer **341** and the inner rigid layer **343**), and at a twofold foam expansion ratio in an outer edge section (with a thickness twice the thickness of the outer rigid layer **341** and the inner rigid layer **343**). This is created by compression-molding only the outer edge section from the inside in the thickness direction of the inner rigid layer **343** after the foamed layer **342** is created at the fourfold foam expansion ratio.

Since the plate-like part **333***a* of the casing **333** shown here has a large section modulus in the central section, the thickness of the outer rigid layer **341** and the inner rigid layer **343** can be made thin, and hence the weight of the plate-like part **33***a* can be reduced. Further, since the amount of penetration of the fiber-reinforced plastic into the outer edge section is limited, the joint strength between the plate-like part **33***a* and the antenna part **33***b*, and between the plate-like part **33***a* and the marginal part **33***c* can be secured.

In addition, since only the outer edge section is compression-molded from the inside in the thickness direction of the inner rigid layer **343**, any indentation caused by compression is not left on the outer surface of the outer rigid layer **341** and hence the appearance is not disfigured.

FIG. **16** illustrates a method of manufacturing a casing material different in form from the method of manufacturing the casing material shown in FIG. **11**. In the method of manufacturing a casing material shown in FIG. **16**, a rigid sheet **71** formed into the outer rigid layer **41** and a rigid sheet **71** formed into the inner rigid layer **43** are first cut out of a rigid sheet, and a foamed sheet **72** formed into a foamed layer is cut out of a foamed sheet. Next, the rigid sheet **71**, the foamed sheet **72**, and the rigid sheet **73** are mutually positioned, laminated in this order, and integrated to obtain the casing material **4**.

In the method of manufacturing the casing material shown here, since the rigid sheet **71** formed into the outer rigid layer **41**, the foamed sheet **72** formed into the foamed layer **42**, and the rigid sheet **73** formed into the inner rigid layer **43** are laminated in this order and integrated after the rigid sheet **71** formed into the outer rigid layer **41** and the rigid sheet **73** formed into the inner rigid layer **43** are cut out of a rigid sheet and the foamed sheet **72** formed into the foamed layer **42** is cut out of the foamed sheet, there is no need to trim the rigid sheet **73** and the foamed sheet **72**.

As has been described, the present disclosure provides a method for manufacturing electronic equipment casing.

While the disclosure has been particularly shown and described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the disclosure.

What is claimed is:

1. A casing for electronic equipment, said casing comprising:

a plate-like part formed by a foamed layer provided between an outer rigid layer and an inner rigid layer to isolate said outer rigid layer from said inner rigid layer, wherein said inner rigid layer includes a step and is made of carbon-fiber reinforced plastic, and said outer rigid layer is made of carbon-fiber reinforced plastic;

an antenna part formed by a single layer of material made of glass-fiber reinforced plastic, wherein said antenna part is joined to said plate-like part at said step to form a first edge of said casing to support an antenna; and

a marginal part formed by a single layer of material made of glass-fiber reinforced plastic, wherein said marginal part is joined to said plate-like part at said step to form a second edge of said casing, wherein the length of said marginal part is shorter than the length of said antenna part.

2. The casing of claim **1**, wherein an outline of said inner rigid layer includes a concave portion.

3. The casing of claim **2**, wherein said outline of said inner rigid layer includes a plurality of depressed portions at predetermined pitches.

4. The casing of claim **1**, wherein an outer edge section of said foamed layer is compression-molded.

5. The casing of claim 2, wherein an outline of said outer rigid layer is a straight edge.

6. The casing of claim 1, wherein said plate-like part is configured to receive a liquid-crystal display.

7. The casing of claim 6, wherein said marginal part is configured to secure said liquid-crystal display.

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